a plurality of bumpers geometrically disposed on the cap wafer for providing overshock protection; and

at least one electrode coupled to the measurement mass wafer,

wherein at least one of the plurality of bumpers and the at least one electrode is adapted to reduce stiction during apparatus operation.

39 ~~2~~. The apparatus of claim 38 ~~1~~ wherein the environmental condition is acceleration.

6' contd

40 ~~3~~. The apparatus of claim 38 ~~1~~, wherein the at least one cap wafer further comprises a top cap wafer and a bottom cap wafer that form a cavity, the measurement mass wafer further comprising a measurement mass housed at least partially within the cavity.

41 ~~4~~. The apparatus of claim 40 ~~3~~, wherein the top cap wafer includes a press frame recess.

42 ~~5~~. The apparatus of claim 40 ~~3~~, wherein the bottom cap wafer includes a press frame recess.

43 ~~6~~. The apparatus of claim 40 ~~3~~, wherein the measurement mass wafer further includes a passage for venting air from the cavity in the housing.

44 ~~7~~. The apparatus of claim 40 ~~3~~, wherein the passage comprises an approximately V-shaped groove in the measurement mass.

45 ~~8~~. The apparatus of claim 38 ~~1~~, wherein a portion of the at least one electrode includes a stiction-reducing pattern.

46 ~~9~~. The apparatus of claim 45 ~~8~~, wherein the electrode pattern includes one or more cavities for reducing stiction between the plurality of bumpers and the at least one electrode.

47 ~~10~~. The apparatus of claim 45 ~~8~~, wherein the electrode pattern includes one or more reduced-thickness recesses for reducing stiction between the plurality of bumpers and the at least one electrode

48 ~~11~~. The apparatus of claim 45 ~~8~~, wherein the electrode portion pattern is selected from a group consisting of

i) a plurality of squares;

ii) a plurality of circles;

iii) a plurality of concentric circles;

iv) a plurality of rectangles; and

v) a series of geometrically arranged pie-shaped segments.

49 ~~12~~. The apparatus of claim 38 ~~1~~, wherein the plurality of bumpers are shaped as at least one of circles and ridges.

B1 Cont'd

50 ~~13~~. A method of fabricating a sensor element, comprising:

using a first process to fabricate a measurement mass wafer for detecting acceleration, the measurement mass wafer including a mass housing having a cavity, and a spring mass assembly positioned within the cavity;

fabricating a top cap wafer using the first process;

fabricating a bottom cap wafer using the first process;

bonding the top cap wafer to a side of the measurement mass wafer using a bonding process;

bonding the bottom cap wafer to another side of the measurement mass wafer using the bonding process; and

making one or more dicing cuts at predetermined locations on the sensor element.

51 ~~14~~. The method of claim 50 ~~13~~ further comprising etching a surface of the measurement mass wafer, applying a metal layer on the etched surface, and molding the metal layer to form a stiction-reducing electrode pattern.

52 ~~15~~. The method of claim 50 ~~13~~, wherein fabricating the measurement mass wafer further includes fabricating a passage for venting air from the cavity.

53 ~~16~~. The method of claim 50 ~~13~~, wherein fabricating the top cap wafer further comprises forming a press frame recess in the top cap wafer.

B1 cont'd

~~17.~~ 54. The method of claim ~~13~~ 50, wherein fabricating the bottom cap wafer further comprises forming a press frame recess in the bottom cap wafer.

~~18.~~ 55. The method of claim ~~15~~ 52, wherein the passage comprises a V-shaped groove.

~~19.~~ 56. The method of claim ~~13~~ 50, wherein the dicing cuts penetrate through the top cap wafer, the bottom cap wafer, and at least partially through the measurement mass wafer.

~~20.~~ 57. The method of claim ~~13~~ 50, wherein the top cap wafer includes a balanced metal pattern on an upper surface of the top cap wafer.

~~21.~~ 58. The method of claim ~~13~~ 50, wherein the bottom cap wafer includes a balanced metal pattern on a lower surface of the bottom cap wafer.

~~22.~~ 59. The method of claim ~~13~~ 50, wherein the spring-mass assembly comprises springs.

~~23.~~ 60. The method of claim ~~22~~ 59, wherein the springs include an etch-stop layer on one or more surfaces of the springs.

~~24.~~ 61. The method of claim ~~13~~ 50, wherein the measurement mass wafer includes one or more mass contact pads; and wherein the dicing cuts are made through the top cap wafer to expose the mass contact pads on the measurement mass wafer.

~~25.~~ 62. The method of claim ~~13~~ 50, wherein the measurement mass wafer includes one or more mass contact pads; and wherein the dicing cuts are made through the bottom cap wafer to expose the mass contact pad on the measurement mass wafer.

~~26.~~ 63. The method of claim ~~13~~ 50, wherein the measurement mass includes one or more mass contact pads and the dicing cuts are made:

through the top cap wafer to expose the mass contact pads on the measurement mass wafer; and

through the bottom cap wafer to expose the mass contact pads on the measurement mass wafer.

64 ~~27~~. The method of claim 52 ~~15~~, wherein the dicing cuts are made through the top cap wafer and the bottom cap wafer and into the measurement mass wafer, stopping at a predetermined distance from the passage within the measurement mass wafer.

65 ~~28~~. The method of claim 64 ~~27~~ further comprising opening the passage after the dicing cuts are made to open an air vent to the passage.

B1 cont'd

66 ~~29~~. The method of claim 65 ~~28~~ further comprising a second process to expose the passage within the measurement mass wafer, wherein air is removed from the cavity through the passage to create a low pressure environment in the cavity, and wherein the passage is sealed to maintain the low pressure environment within the cavity.

67 ~~30~~. The method of claim 65 ~~28~~, further comprising packaging the sensor element in a sensor housing and using a vacuum process to remove substantially all air from the sensor housing during packaging to create a low pressure environment within the sensor housing; wherein air is removed from the accelerometer though the passage during the vacuum process; and wherein the sensor housing is sealed to maintain the low pressure environment.

68 ~~31~~. A method for protecting a sensor during operation, the sensor comprising a housing, a measurement mass wafer coupled to the housing for detecting an environmental condition, at least one cap wafer coupled to the housing and at least one electrode coupled to the measurement mass wafer, the method comprising;

providing overshock protection to the sensor using a plurality of bumpers geometrically disposed on the cap wafer; and

adapting at least one of the plurality of bumpers and the at least one electrode to reduce stiction during sensor operation.

69 ~~32~~. The method of claim 68 ~~31~~, wherein the environmental condition is acceleration.

~~33~~ 70. The method of claim ~~31~~ 68 further comprising using a stiction-reducing pattern on a portion of the at least one electrode to reduce stiction between the at least one electrode and the bumpers.

~~34~~ 71. The method of claim ~~33~~ 70, wherein the electrode pattern includes one or more cavities for reducing stiction between the plurality of bumpers and the at least one electrode.

~~35~~ 72. The method of claim ~~33~~ 70, wherein the electrode pattern includes one or more reduced-thickness recesses for reducing stiction between the plurality of bumpers and the at least one electrode

B' end

~~36~~ 73. The method of claim ~~33~~ 70, wherein the electrode pattern is selected from a group consisting of

i) a plurality of squares;

ii) a plurality of circles;

iii) a plurality of concentric circles;

iv) a plurality of rectangles; and

v) a series of geometrically arranged pie-shaped segments.

~~37~~ 74. The method of claim ~~31~~ 68, wherein the plurality of bumpers are shaped as at least one of circles and ridges for reducing stiction between the bumpers and the at least one electrode.

Respectfully submitted,

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